REMR TECHNICAL NOTE EM-MS-1.2

DAM GATE SEAL HEATERS

PURPOSE: To summarize the results of an in-depth study of the Corps of Engineers' experience with gate-seal heaters for 40 dams on the Monongahela, Ohio, Mississippi, Columbia, and Illinois Rivers (rivers where freezing-water conditions exist during at least a part of the winter). Availability and analysis of this information is considered significant because it can be useful in selecting the most viable and cost-effective design options for gate-seal heaters.

BACKGROUND: Engineer Manual 1110-2-2703, "Lock Gates and Operating Equipment," states that two types of heating systems can be used for mitigating ice formation and for the thawing of ice at gate seals. These are: (a) direct heating of the seals using electrical resistance elements inserted behind the seal faces/plates, and (b) circulation of electrically heated heat-transfer solutions (oil or glycol-water) through pipes/tubes located behind and close to the seal faces/plates.

For direct electrical heating, replaceable heating elements are installed in recesses behind the seal faces in the piers with the recesses being insulated (usually with sand) so that the heat generated is directed toward the surfaces to be heated. For heating by circulating electrically heated heat-transfer solutions, the pipes/tubes used to contain the product to be conveyed are located behind the seal faces and close to the surfaces to be heated. Thermostatically controlled immersion-type electrical-heating units heat the heat-transfer solution such as oil or glycol-water which is pumped through the pipes/tubes.

RESULTS OF STUDY: Examination of data from 40 dams revealed that 23 have/had side-seal heating systems, 3 have circulating, electrically heated heat-transfer solution systems, and 20 have/had direct heating using electrical resistance elements. Only 2 dams have bottom seal heating systems. Of the 23 dams with side-seal heating systems, 15 have fully operational systems, 4 have systems requiring repairs, 2 have systems which are not operational, and 1 has a system for which the operational status is not known. Only 14 of the 23 dams with gate heating systems actually use them. The most commonly cited reason for not using the heaters is that they are not required for gate operation during cold weather.

Operating personnel contacted at the dams which have gate seal heaters expressed the following concerns regarding direct heating using electrical resistance elements:

a. Shorted/burned-out elements which cannot be readily replaced.

b. The cost of replacing elements.

c. The cost of electricity.

d. The need for an easy method of testing individual resistance elements at the top of the dam.

It should be noted that electrical resistance elements have been used without serious maintenance problems for as long as 53 years on roller gates on the Mississippi River and as long as 21 years on tainter gates on the Monongahela River.

Although the usage of circulating electrically heated heat-transfer solution gate-seal heating systems has been somewhat limited, the experience to date is reasonably good. The only concerns expressed by operating personnel regarding this heating concept were:

a. Minor leaks due to corrosion of the steel pipe interiors by circulation of the glycol-water solutions or stress placed on the pipe by expansion and contraction.

b. The need to maintain oil heaters, pumps, and relatively long pipe/tube networks.

c. Difficulty in locating leaks.

d. Difficulty in repairing leaks.

This form of gate-seal heating has been used for the tainter gate at Upper St. Anthony Falls Dam on the Mississippi River for 31 years with only one leak.

VIABLE OPTIONS: Based upon the results of this investigation, it appears that the most viable options for seal heating the tainter and roller gates at dams would be:

a. Direct heating using electrical resistance elements for the roller gates.

b. Circulating electrically heated heat-transfer oil (not water-glycol solutions) for the tainter gates, with a corrosion inhibitor maintained in the oil.

c. The use of a heat-transfer oil system when the bottom seals of gates require heating.

d. The installation of seal heating systems only after it is clearly established that they will be required for gate operation.

e. Joining the pipes for the heat-transfer oil heating systems by welding (not threading) and thoroughly inspecting the pipe networks for leaks before they are sealed/grouted.

f. Electrical resistance elements for tainter gates, so that embedments can be located integral with the concrete structure.

g. Circulation of electrically heated solution through pipe attached to the gate surface, because it is unrealistic to cut back into existing concrete to embed electrical resistance elements.

h. Avoiding contact between the heat-transfer oil pipe networks and chloride-containing grout/concrete.

i. Schedules 40 and 80, carbon-steel pipe satisfying the requirements of American Society for Testing and Materials (ASTM) Standard Specification A 120 (i.e., for galvanized-steel pipe) should be used, respectively, for the exposed and concrete grout embedded portions of the pipe networks associated with the heat-transfer oil heating systems.

CONCLUSIONS: Based on the evaluation of the information collected during this investigation, direct heating using electrical resistance heaters should be used for side seals only after it is clearly established that it will be required for dam gate operation.